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AUTHORITY

NATF ltr dtd 2 May 1974

NATF(SI) REPORT OF TEST RESULTS
NATF(SI) 13800/16 (3/67)

REPORT NO: NATF(SI)-R2
DATE: 16 May 1967

NATF(SI) REPORT OF TEST RESULTS

FROM
Commanding Officer, NATF(SI), Lakehurst, N. J. 08733
TO
Commander, Naval Air Systems Command (AIR-5373), Washington, D. C. 20360

AIRTASK	WORK UNIT	EFFORT LEVEL
A 05 537-007/204/ 1/S-416-00-05	AIR-5373-211/204/1 TASK NO. 211-1	NORMAL

PROJECT TITLE

Shipboard arresting-gear fleet support; Mark 7 arresting-system improvement support (epoxy-poured terminals)

DATES OF TESTS	LOCATION OF TEST
21 November 1966 through 31 March 1967	Recovery Systems Track Site (RSTS) No. 5

NATF(SI) PROJECT ENGINEER

James Daley

ENCLOSURES

☒ PHOTOGRAPHS ☐ DRAWINGS ☒ TABLES ☐ CURVES ☐ APPENDIX

RESULTS (Introduction, Results and Discussion)

Ref: (a) Report NATF-E-1081 of 7 Mar 1966: Use of Epoxy in Wire-Rope Terminals, Interim Report

INTRODUCTION

1. This Facility has been investigating the feasibility of using epoxy in arresting-gear wire-rope terminals at RSTS No. 5 since March 1962, and at the Runway Arrested Landing Site since November 1962. The use of epoxy in wire-rope terminals is less time consuming, complex, and hazardous, and requires fewer tools and appliances than zinc. Tests were very successful and clearly demonstrated that an epoxy resin could replace zinc in cable terminals. On 31 March 1967, however, three epoxy-poured terminals failed during one arrestment.

TEST EQUIPMENT AND PROCEDURE

2. Four epoxy-poured terminals were prepared in accordance with Appendix A of reference (a). Each was proofloaded to 120,000 pounds prior to testing and found to be satisfactory. The terminals were installed in the Mark 7 Mod 3 arresting system at RSTS No. 5. Tests were conducted 20 feet OFF-CENTER to port with 12,000- to 70,000-pound deadloads at engaging speeds ranging from 90 to 150 knots.

TEST RESULTS AND DISCUSSION

3. Three of the epoxy-poured terminals (two anchor terminals and one deck terminal) failed during event 102: 70,000-pound deadload at an engaging speed of 123 knots. The following tension levels were recorded at the time of the failures:

Terminal	Tension Level (Pounds)
Starboard anchor	87,000
Port anchor	141,000
Port deck	120,000

A history of the 102 arrestments is presented in tabular form in enclosure (1).

4. An inspection of the failed terminals revealed that the broomed wire rope slipped from the terminals; the epoxy plug, or potting material, was left intact in each terminal, as shown in enclosure (2). During an inspection of the terminals immediately prior to the failures, no epoxy recession nor wire slippage was noted.

5. Investigation of the cause of terminal failure indicates that either the epoxy was improperly cured or the broomed wire was improperly/insufficiently cleaned. The investigation, therefore, was furthered to determine the exact cause.

a. Improperly Cured Epoxy. In accordance with the pouring instructions of reference (a), the terminal is preheated to 113 to 120°F before the epoxy is poured and maintained at that temperature after the epoxy is poured and until it has solidified (approximately 25 to 30 minutes). After solidification, the epoxy is post cured for approximately 30 minutes: the terminal is maintained at a temperature of 113 to 120°F. Then the epoxy is allowed to air cool. This method results in properly cured epoxy with a Rockwell Hardness indication of approximately 81 to 99.5 on the F scale. The hardness of the epoxy remaining in the failed terminals was checked and yielded an average Rockwell Hardness of 76 on the F scale. Accordingly, from this test, it appears that the epoxy was not properly cured and that this could be the primary cause for the terminal failures.

b. Improperly/Insufficiently Cleaned Broomed Wire

(1) An interview of the various personnel who poured the failed terminals on 21 and 22 November 1966 indicates that the cleaning, pouring, and curing procedures utilized were not altered or interrupted, and that the reference (a) epoxy pouring instructions were adhered to in all respects. In addition, each terminal was proofloaded to 120,000 pounds prior to testing and found to be satisfactory.

(2) NAEL(SI) conducted an evaluation of epoxy-poured terminals. During their program, they deliberately cleaned the broomed wire rope improperly prior to pouring epoxy. The appearance of NAEL(SI)'s resultant failed terminals was identical to that of the three that failed at this Facility. Although the terminals poured by NAEL(SI) failed at very low loadings during pull tests, as compared with the loads experienced by our terminals during operations, the thought that the broomed wires might not have been properly cleaned was considered as a possible contributing cause for the failures. In order to obtain evidence of any contamination, the broomed wires of the failed terminals were microscopically examined; unfortunately, the broomed wires were grossly contaminated immediately after the terminal failure and thus any evidence was erased. Also, attempts were made to have a chemical analysis made of the epoxy remaining in the failed terminals to determine the presence of any contamination remaining from the improperly cleaned wire. Discussions with chemists from the Aeronautical Materials Laboratory, Philadelphia, Pennsylvania, and the Toms River Chemical Company, Toms River, New Jersey (manufacturers of epoxy resins), indicate that such an analysis would be exceptionally difficult, if not impossible, because of the filler utilized in the epoxy and possible carbonization of any contamination due to the exothermic chemical reaction during curing of the epoxy. Any results obtained from such an analysis, therefore, would be inconclusive.

CONCLUSIONS AND ACTION

6. In accordance with the above, a definite cause for the premature failure of the terminals cannot be determined; however, all evidence indicates that incomplete curing of the epoxy terminals was the primary cause.

7. To eliminate improper curing, special terminal heaters have been designed and procurement initiated. These heaters fit over the terminal and are electrically controlled to maintain a terminal temperature of 115°F before and during post cure. In addition, the "hot tops" removed from all terminals will be tested for hardness by means of a Rockwell Hardness tester to assure that proper post cure has been achieved.

C. T. Abrahamsen

C. T. ABRAHAMSEN
By direction

DISTRIBUTION

CNO (Op03EG)	(2)
DDC	(20)
NAEL(SI)	(2)
NAVAIRSYSCOM (AIR-604)	(2)
NAVAIRSYSCOM (AIR-5373)	(2)

INTERNAL DISTRIBUTION

4000	(2)
4200	(2)
4010	(1)
4020	(1)
1202	(1)

Deadload Weight (Pounds)	Engaging Speed (Knots)	Maximum Cable Tension (Pounds)		Maximum Anchor Tension (Pounds)	
		Port	Stbd	Port	Stbd
12,000	114	47,000	43,000	12,400	14,700
12,000	124	66,000	60,000	26,800	20,800
12,000	129	71,400	61,000	42,400	24,000
12,000	142	78,200	66,500	20,500	24,200
12,000	111	58,000	48,700	10,000	11,900
12,000	117	65,500	52,000	11,200	15,200
12,000	123	66,000	56,500	14,500	18,900
12,000	138	91,000	66,000	26,100	23,600
12,000	130	82,000	61,000	19,100	21,400
12,000	140	91,500	67,000	22,400	29,600
12,000	118	67,000	55,000	11,900	8,500
12,000	110	60,500	54,000	9,350	8,400
12,000	128	70,000	63,000	16,900	18,800
12,000	138	76,000	66,900	25,700	23,800
12,000	124	60,600	58,600	18,100	18,600
12,000	133	65,500	61,800	26,700	22,800
12,000	146	76,000	76,600	27,400	36,500
12,000	111	54,400	46,200	12,100	13,500
12,000	150	77,600	71,000	31,300	39,000
12,000	142	53,400	66,200	25,000	33,200
12,000	151	82,500	76,100	39,400	53,600
12,000	135	65,000	65,600	20,100	28,500
12,000	122	59,000	56,100	16,500	20,000
12,000	110	54,700	50,200	13,800	12,000
12,000	111	57,600	48,900	11,800	8,950
12,000	120	57,700	53,000	13,800	10,000
12,000	139	73,000	64,500	19,500	17,200
12,000	132	70,600	59,600	20,900	11,900
12,000	150	76,000	73,100	24,200	24,300
12,000	112	51,400	48,000	10,400	6,700
12,000	120	61,200	51,000	13,200	11,400
12,000	131	76,800	67,600	31,900	31,700
12,000	141	75,100	66,700	19,200	21,700
12,000	152	75,400	66,800	26,700	29,000
25,000	102	61,600	48,300	24,300	17,400
25,000	117	66,500	62,900	31,800	26,900
25,000	128	88,900	61,500	38,500	27,400
25,000	138	88,500	73,500	44,500	36,700
25,000	102	54,100	48,400	22,900	22,500
25,000	125	69,600	55,600	28,500	24,300
25,000	116	62,500	52,600	28,700	24,700
25,000	128	83,200	59,500	36,600	30,600
25,000	136	83,000	68,000	46,100	35,900
25,000	140	85,300	75,000	44,000	38,300

ENCLOSURE (1) - HISTORY OF 102 ARRESTMENTS CONDUCTED WITH FOUR EPOXY-POURED TERMINALS (POURED ON 21 AND 22 NOVEMBER 1966) INSTALLED IN MARK 7 MOD 3 ARRESTING SYSTEM AT RSTS NO. 5

REPORT NO: NATF(SI)-R2

Deadload Weight (Pounds)	Engaging Speed (Knots)	Maximum Cable Tension (Pounds) Port	Maximum Cable Tension (Pounds) Stbd	Maximum Anchor Tension (Pounds) Port	Maximum Anchor Tension (Pounds) Stbd
33,000	117	70,500	53,700	52,500	36,100
33,000	113	63,000	52,600	49,500	18,900
33,000	128	82,500	64,700	61,400	39,700
33,000	140	79,000	72,500	67,500	46,400
33,000	121	75,500	61,400	59,500	41,200
33,000	130	85,700	64,000	60,000	41,100
33,000	120	81,000	56,000	48,000	36,200
33,000	129	81,400	62,400	52,400	48,000
33,000	141	95,000	75,400	61,300	55,300
33,000	108	107,000	81,200	109,000	88,600
33,000	119	63,100	57,000	52,400	40,400
33,000	111	56,700	49,700	41,900	33,000
33,000	120	67,400	54,500	48,600	38,000
33,000	121	71,600	61,600	45,500	36,300
33,000	130	78,000	68,500	52,400	43,200
33,000	110	56,400	41,600	37,900	28,500
33,000	122	65,000	54,000	47,000	36,000
33,000	130	78,400	61,000	48,500	42,700
33,000	142	78,400	72,000	61,400	49,400
33,000	135	90,500	70,400	59,500	46,100
33,000	140	92,800	78,000	62,900	48,100
33,000	121	71,600	56,700	42,300	33,200
33,000	112	66,700	50,700	37,900	31,100
33,000	112	58,900	51,000	37,900	31,100
50,000	109	71,500	60,000	58,000	47,300
50,000	118	85,600	60,000	79,400	57,000
50,000	123	91,000	73,100	85,600	59,500
50,000	136	98,000	81,500	91,500	75,200
50,000	131	95,300	80,000	81,700	65,800
50,000	130	97,900	73,200	79,100	69,000
50,000	141	110,000	79,000	106,000	74,500
50,000	142	96,700	80,500	91,600	79,500
50,000	92	50,000	34,200	42,000	31,800
50,000	106	60,000	43,200	56,700	42,500
50,000	109	59,200	48,000	55,400	44,600
50,000	118	68,100	56,800	66,300	55,500
50,000	130	84,500	67,700	79,800	65,700
50,000	130	83,900	71,000	80,500	67,500
50,000	119	68,100	49,600	64,900	52,000
50,000	109	62,600	56,700	53,800	46,700
50,000	101	54,500	36,500	48,200	39,000
50,000	92	45,900	34,500	36,100	31,800
50,000	141	97,400	81,400	92,100	75,200
50,000	142	88,200	81,300	90,500	79,000
50,000	99	50,800	41,400	48,300	36,600
50,000	109	58,000	51,800	58,000	47,600
50,000	110	48,500	39,600	44,600	38,000

Deadload Weight (Pounds)	Engaging Speed (Knots)	Maximum Cable Tension (Pounds)		Maximum Anchor Tension (Pounds)	
		Port	Stbd	Port	Stbd
50,000	91	46,100	38,400	39,600	33,300
50,000	108	59,600	52,100	56,500	46,800
50,000	119	72,000	63,500	66,600	56,600
50,000	118	70,500	60,600	63,000	52,200
50,000	131	80,600	74,000	80,000	68,500
50,000	130	86,500	72,600	80,600	67,300
50,000	131	84,000	72,400	81,500	67,500
70,000	94	64,600	56,700	66,500	52,800
70,000	105	81,600	71,300	77,000	68,800
70,000	110	84,000	73,900	82,400	76,000
70,000	123	114,000	100,000	141,000	87,000

ENCLOSURE (2) - FAILED EPOXY-POURED TERMINAL (BROOMED WIRE PULLED COMPLETELY OUT OF TERMINAL--NO EPOXY RECESSION)